Name: **Enrolment No.:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course : Transport Phenomena **Semester : III**
Program : B.Tech. Chemical Engineering (spl. RP); CE-RP **Time : 03 hrs.**
Course Code: CHCE2014 **Max. Marks : 100**

Instructions: (i) THIS IS AN OPEN BOOKS AND NOTES EXAM (PRIOR PERMISSION TAKEN).

(ii) PLEASE RETURN THE QUESTION PAPER ALONG WITH YOUR ANSWER SCRIPTS

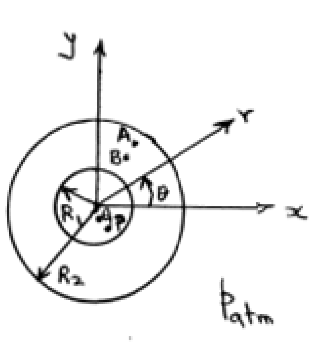
SECTION A (NO QUESTIONS HERE SINCE IT IS AN OPEN BOOKS AND NOTES EXAM)

S. No.		**Marks**	**CO**
Q	x	**-**	**CO1**

SECTION B (NO QUESTIONS HERE SINCE IT IS AN OPEN BOOKS AND NOTES EXAM)

Q	x	**-**	**CO4**

SECTION-C (<u>ALL</u> THREE QUESTIONS IN SECTION C ARE COMPULSORY)

Q 1	A cyclone (tornado) has a tangential velocity, v_θ (***only***, i. e., v_z and v_r are zero), given by $v_\theta = K/r$; for $r \geq R_1$  and $v_\theta = \omega r$; for $r \leq R_1$	**Marks**	**CO5**

where, K and ω are constants.

(a) Assuming that the θ velocity is continuous at $r = R_1$, obtain the relation between K and ω. (7)

(b) The pressure outside the domain of the cyclone, i.e., for $r \geq R_2$, is 1 atm. Calculate the pressure at a radius, r, in the outer region, i.e., $R_1 \leq r \leq R_2$. Assume that the Engineering Bernoulli Equation applies to any two points, A and B, in this region (assume $z_A = z_B$) and also assume $w_l = 0$). (8)

(c) If the outer pressure ($r \geq R_2$) is atmospheric, is the pressure inside at $r \leq R_2$, lower or higher than 1 atm. (7)

(d) The pressure in the *core* of the cyclone, for $r \leq R_1$ (where $v_\theta = \omega r$ and there are ***no*** shear stresses) is given by

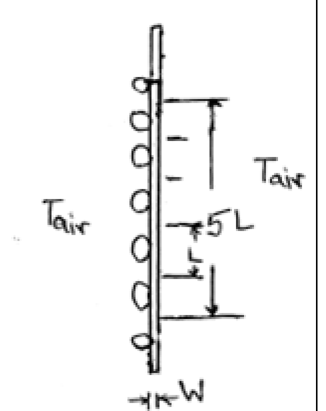
$$p_P - p_Q = \rho\omega^2(r_P^2 - r_Q^2)/2$$

Find the pressure at $r = R_1/2$. Is it lower than the pressure at $r = R_1$. (8)

(***Total 30 Points***)

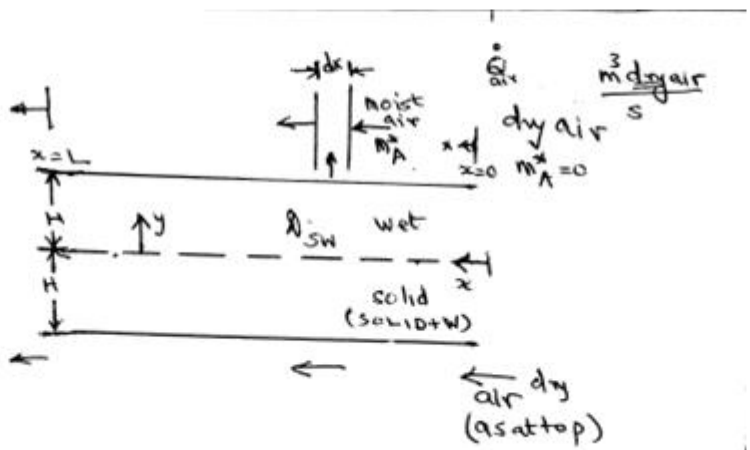
Q 2

In one of the refrigerator brands, the '*heat*' picked up from the *inside* of the refrigerator is dissipated at the back through a large steel plate (cross section shown in the diagram). The outer temperature of the pipe (carrying the hot refrigerant) is T_1. Write down the thermal energy balance for the plate. Make sure you give the differential equation (25 Points) as well as ***ALL*** the boundary conditions (10 points). Assume the heat transfer coefficient from the plate to the surrounding air is a constant, h. Also, assume steady state.



(***Total 35 Points***)

Q 3 Consider the drying of a slab of wet solid by the flow of drier air on both sides (as shown in the diagram). The diffusivity of water, A, in the wet *solid* is D_{SA}. If the mass transfer coefficient at the top of the wet solid is k^*_{gA}(mol A/m^2-s-Δc), write a molar balance for water between x and x + dx. Simplify as much as possible.



(***Total 35 Points***)

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